Comments on NRG-Sunrise Power Company Responses to the June 30, 2015 EPA Comments on the Amended Class I Non-Hazardous Permit Renewal Application

The numbered comments refer to the November 2015 NRG-Sunrise responses to the EPA comments presented in the June 30, 2015 letter to NRG Energy Inc. (NRG aka NRG-Sunrise). These EPA comments were on the NRG April 2015 amended permit renewal application. The amended application has been updated to address the 42 EPA comments in the June 30 letter. The responses that are omitted below are considered acceptable by EPA and can be excluded from further discussion. The remaining major concerns and comments are related to the presence of a potential underground source of drinking water (USDW) within the area of review (AOR), the aquifer exemption (AE) issue, and the determination of the proposed AOR.

2. Area of Review Method: A computer simulation of the injected fluids distribution over the operational life of the injection wells is provided as requested, but a discussion of the model design and input parameters is lacking in detail.

Please provide an expanded discussion of the basis for the simulation, including the variability of transmissivities during the model simulation period and the degree of saturation and unsaturated/saturated hydraulic properties specified for the model layer as presented on page A-19. Please discuss the basis for the saturated hydraulic conductivity of 30 feet/day. That value is not consistent with saturated permeabilities (K_w) based on fall-off test (FOT) analyses in the WW3 well, which varied from 45 to 191 millidarcies in the 2004 to 2013 annual FOTs.

> *[**Note to EPA:** The K_w of 30 ft. /day is apparently based on core permeabilities in the 30F-72T monitoring well and equates to a core permeability of approximately 10.95 Darcies.]*

The FOT analyses of K_w was based on a net reservoir thickness of 600 feet while the model layer thickness was 450 feet and the volumetric calculation of the ZEI was based on a 133 feet thick injection zone with an average porosity of 30 percent, or 40 net feet of porosity times thickness. The assumption of a uniform thickness of 450 feet is not a conservative approach since the injection zone gross thickness varies from 250 to 470 feet (pg. A-12). Furthermore, the Upper Tulare sands are separated vertically by interbedded shales that are laterally continuous.

The model design should account for these layers of shale and variation in thickness as they would result in an increase the lateral fluid migration.

Model boundaries (lateral and vertical) should be discussed. Is it assumed that there is no water leakage into the injection formation through boundaries?

Initial conditions need to be described for the model. Particularly, the initial distribution of the saturation values in the model domain is needed. Also note that the initial saturation values should account for the effects of any previous injection activities in the model domain as well as the saturation values in the upper and lateral portions of the injection formation.

It is unclear if the applicant accounted for any residual water saturation for the calculation of the net thickness of air space. It is indicated that the net thickness is calculated for the formation thickness and porosity. However, porosity itself does not indicate the available pore (i.e., air) space.

Calculation of available pore space should also account for the residual water content in the formation, which would ultimately reduce the "net thickness of air space" and, therefore, increase the distance of injected fluid travel and pressure effects.

Please discuss and justify the model size and input parameters applied in the model simulations. Please review model inputs and assumptions and rerun the simulation for consistency with the input values in the volumetric calculation of ZEI and FOT transmissivities. The model simulation should be rerun with different input parameter values as discussed above to test the model for sensitivity to a thinner injection zone layer or layers and a lesser permeability to water, K_w, and other inputs including the van Genuchten soil characteristics. Model results should also include vertical and lateral saturation distributions. Please modify the ZEI and proposed AOR accordingly.

> *[**Notes to EPA:** The ZEI as depicted in Figure 2 will change with revised input parameter values. A smaller input value for K_w would decrease the ZEI; however, a smaller input value for net porosity thickness would increase ZEI. The core permeability measured in the 30F-72T monitoring well was probably based on air permeability rather than permeability to a water saturated core, K_w. The FOT permeabilities are much lower than the core permeabilities and are more representative of K_w since the FOTs were performed after injection of water into an air saturated zone. However, the relative permeability of water to air would probably increase as more water in injected, and that appears to the case since annual FOT permeabilities increased over time. In addition, the reservoir pressure at a given distance from an injection well would increase proportionately with a decrease in reservoir thickness, but it would decrease logarithmically with a decrease in permeability. In other words, reservoir pressure is more sensitive to reservoir thickness than to permeability at a given distance from an injection well.*
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> *Another variable to consider is the injection history in pre-existing Class II water injection wells within the ZEI of the Sunrise injection wells. There are 13 former Class II injection wells within the proposed AOR that were plugged and abandoned between 1985 and 1992. All but one was apparently always used for air injection in a fireflood operation to increase oil recovery in the basal oil sands. I found one well of that group (the PMO 403 well) that was converted to a water disposal well in 1976 and was plugged in 1985, The PMO 403 well is located within 500 feet of the WW3 well and within 1,000 feet of the WW4 well and injected into the basal oil sands. The amount of water injected in that well is unknown but would have some effect on the ZEI of the Sunrise injection wells since the WW3 and WW4 wells are screened through the basal oil sands. The volume injected in that well is unknown and may not be available but it would support a larger*

and more conservative estimate of the ZEI. The volume of air injected in the 13 wells is probably not relevant since it would have been consumed in the fireflood or dissipated in the air sands above the oil sands. The waste water injection pressure in the PMO 403 well may also have dissipated since the well was abandoned in 1986, but the injected waste water will still be present in the Upper Tulare Formation whether in the oil sands or the air sands situated just above the oil sands. Injection in the PMO 403 well was into the oil sands, but water could have migrated upward into the underpressured air sands.

Should the minimum size of the AOR be no less than ½ mile in radius from the injection wells? If so, the AOR would include some wells that are located beyond the model ZEI. The model ZEI is somewhat smaller in size than the former AOR, which was based on the ½ mile radius standard. The model simulation should be rerun with different input parameter values as discussed above to test the model for sensitivity to a thinner injection zone layer and a lesser permeability to water, K_w, and other inputs including the van Genuchten soil characteristics. Model results should also include vertical and lateral saturation distributions. The ZEI would be larger if only model layer thickness is reduced but smaller if only K_w is reduced.]

4. Zone of Endangering Influence: This comment relates to the probable presence and extent of a USDW within the zone of endangering influence (ZEI) and proposed AOR. NRG contends that the Upper Tulare Formation contains thin perched water zones in relatively small areas within the proposed AOR, based on well log calculations, but concludes that those zones do not constitute a USDW. We have reviewed those calculations and have also performed log calculations for TDS concentrations in the four existing injection wells. The results of our calculations indicate the presence of water saturation in sand lenses located within the upper 125 feet of the Upper Tulare Formation in the four injection wells. The saturated intervals are open to injection in the WW3, and WW4 injection wells, and were open in the B-122 well before it was plugged and abandoned.

Please review and provide calculated TDS values for the water saturated intervals in the uppermost portion of the injection interval in the four injection wells. We recommend the resistivity/porosity equation over the spontaneous potential method for calculating formation water resistivity and TDS values.

Furthermore, the Upper Tulare Formation is water saturated with TDS concentrations under 10,000 parts per million (ppm) NaCl in the two wells located just beyond the western boundary of the proposed AOR, and in a third well northwest of the proposed AOR, based on the NRG consulting firm log calculations (NORCAL), which are consistent with our interpretation and log calculations. Figure B-2 depicts the eastern extent of that aquifer to extend to a position approximately 1,500 feet east of the western boundary of the proposed AOR. The NORCAL TDS concentrations in the Upper Tulare Formation waters range from 1,250 to 6,100 ppm NaCl, which are consistent with our calculations based on electrical resistivity and porosity of Upper Tulare sand lenses. Based on log calculations for TDS concentrations and the proposed AOR as

depicted Figure B-2, we believe the Upper Tulare Formation is partially to fully saturated within the proposed AOR with groundwater that can be considered a potential USDW.

Consequently, an aquifer exemption is required for continued injection into the Upper Tulare Formation within the proposed AOR of the wells as discussed below.

5. Regional Geology: Response is mostly acceptable but incomplete with regard to the analysis of potential water saturated intervals in the four injection wells as discussed above in comment 4. An analysis of log responses was provided for the B-122 well, which indicates at least 30 net feet of water saturated sand from 490 to 530 feet.

Please provide your assessment of water saturation in the upper portion of the Upper Tulare Formation in the A-72TR, WW3, and WW4 wells and other wells within the AOR. Please revise Figure B-2 to show the revised lateral extent of water saturation in the Upper Tulare Formation based on that assessment.

9. Response on Page C-4: Corrective action requirements. NRG contends that a USDW does not exist in the proposed AOR as discussed in Attachment A. Based on a review of the water saturation data derived from well log analysis, EPA believes that portions of a USDW are present in the Upper Tulare Formation within the proposed AOR and requires an aquifer exemption. No portion of the Upper Tulare Formation in the Midway-Sunset Oil Field is currently exempt, contrary to the assertions by NRG in the updated permit renewal application.

NRG should therefore submit a request and justification for an aquifer exemption for the Upper Tulare Formation within the AOR for the Sunrise Class I NH injection wells.

10. Table C-1, Tabulation of All Wells within the AOR: Table C-1 was updated to list wells located within the amended AOR. The AOR is somewhat smaller than was proposed in previous submittals of the original and permit renewal application. Twelve wells were omitted from Table C-1 as a result of that revision as presented in Figures B-2, Aerial Map of Area of Review. The locational and other well information required in this tabulation is not provided.

Please add the location of each well by distance from the closest section lines to the tabulation in Table C-1. In addition, please insert updated well schematics for all wells located within the AOR in Attachment C. If any of the required well information identified under "Permit Requirements" on page C-3 is presented in the schematics, that information may be omitted from the tabulation of AOR well information.

> *[**Note to EPA:** Is the omission of information in the tabulation acceptable if presented in the schematics?]*

11. Maps and Cross Sections of USDWs: The basis for stating that the nearest USDW is located 7 to 8 miles to the east of the Sunrise injection wells is not acceptable, based on the assessment of potential USDWs in the Upper Tulare Formation located within the AOR and in the Midway-Sunset Oil Field to the west of the AOR, as discussed above.

Please amend the NW-SE cross section A-A' in Figure F-3 to include the WW3 and WW4 injection wells and the WPMO 210 well, and depict the intervals of potential USDWs in the Upper Tulare Formation. Please enlarge the SW-NE cross section B-B' in Figure F-3C to include wells to the west of the AOR, including API Nos. 02943188 and 02941989 and add the WW3 and WW4.injection wells to the cross section. Please depict the intervals of potential USDWs in the Upper Tulare Formation in the cross sections.

12. Figures F-4, F-5, F-6, and F-7: The AOR depicted on the maps in these figures is not consistent in size and shape with the AOR depicted in Figure 2 in Attachment A and Figure B-2 in Attachment B.

Please review and amend the AOR size and shape on these maps to be consistent with the revised ZEI based on model adjustments discussed in Comment 2 above.

> *[**Note to EPA**: If the AOR is based on a minimum of ½ mile distance from the injection well locations, as discussed in Comment 2, the ZEI determined from model results may be smaller than the AOR determined on a minimum ½ mile distance basis.]*

13. Page H-6, Mechanical Integrity Tests, APTs: The pressure recording charts for each annular pressure test (APT) were provided but not the APT reports. The Chart scales are too large (0 to 10,000 psi) to discern the pressure change for pass/fail of 5% and there were no remarks provided on the WW3and WW4 well charts to indicate whether the wells passed or failed the APT. The A-72TR and B-122 wells apparently failed the APTs based on the remarks written on the charts.

Please provide the signed APT reports if reports were prepared for the four APTs. If not prepared, please ensure that APT reports are provided in the future and please use a recording chart with an appropriate pressure and time scale such as 1,000 psig and one hour. APT report forms are available by request at EPA Region 9.

> *[**Note to EPA**: Is this last sentence accurate?]*

16. Page H-14, FOT report for 2015: The latest FOT (fall-off test) was performed in September 2015 and the FOT report was pending according to a statement on page H-12 in the updated application.

Was the FOT report submitted to EPA? Please add a copy of the report to the updated application.

22. Page L-4, Well Siting & Injection Formation: An aquifer exemption is required for disposal of Class I or II fluids into the Upper Tulare Formation in the Midway-Sunset Oil Field as discussed above.

Please submit a request and justification for an aquifer exemption for the Upper Tulare Formation within the AOR for the Sunrise Class I NH injection wells if NRG plans to continue injection into the WW3 and WW4 wells and drill and initiate injection into the proposed WW5 and WW6 wells. Injection into a deeper formation would require a modified permit renewal application and a major permit modification or issuance of a new permit.

29. Page P-8, Quarterly Reports Submittal:

Please correct the typo in the EPA mailing address to San Francisco.

33. Figure Q-3, Well WW3 schematic of P&A Plan: The Plugging and Abandonment (P&A) Plan schematic for the WW3 well is missing.

Please add Figure Q-3, WW3 P&A Plan schematic to Attachment Q.

34. Figure Q-4, Well WW4 schematic of P&A Plan: The long string casing size and specifications and hole size are still missing from the schematic.

Please add that information to the well schematic.

37. Exhibit Q-2, Records Relating to P&A of Well A-72T: The well schematic for Well A-72T is provided as requested but the long string casing specifications and hole size are missing from the schematic.

Please add that information to the well schematic.

38. Exhibit Q-3, Records Relating to P&A of Well B-122: The final B-122 P&A schematic is not provided and page Q-16 is missing.

Please add the schematic and page Q-16 to Attachment Q.

39. Page R-4, Financial Assurance: Performance bond # 0190566 is for the A-72T well (API # 03020864), which was plugged and abandoned and replaced by the A-72TR well (APR # 03038915).

Please revise or replace this bond to identify the covered well as the A-72TR well.

40. Page S-4, Aquifer Exemption for the Upper Tulare Formation: The lack of an aquifer exemption for the Upper Tulare Formation within the proposed AOR is not acknowledged by Sunrise and is not consistent with the discussion of the aquifer exemption issue on page L-4 in Attachment L, which acknowledges that Sunrise would be required to request an aquifer exemption if the WW5 and WW6 wells were to inject into the Upper Tulare Formation. EPA does not recognize that any part of the Upper Tulare Formation was exempted in the Midway-Sunset Oil Field in the EPA approval of the 1981 application for Primacy of the Division of Oil, Gas, and Geothermal Resources (DOGGR) Class II UIC program or the associated MOA between EPA and DOGGR. Moreover, an exemption for injection of Class I fluids into the Upper Tulare Formation is required for the existing and proposed Sunrise injection wells because the Upper Tulare Formation contains groundwater that qualifies for classification as a potential USDW, based on geophysical log analysis of wells within and in close proximity to the proposed AOR.

If you plan to continue injection into the Upper Tulare Formation, please include an application for an aquifer exemption of Class I fluids with the permit renewal application.

41. Page S-4, Summary of USDW and Aquifer Exemption Issues: EPA and Sunrise agree that the geophysical log analysis indicates that water saturated intervals are present in the Upper Tulare Formation sands in wells located within and near the western and northwestern perimeter of the proposed AOR. NaCl concentrations range from 1,250 to 6,100 ppm based on NORCAL Consulting calculations using the spontaneous potential method and from 3,100 to 10,000 ppm based on EPA calculations using formation resistivity and porosity values. However, NORCAL did not evaluate the A-72TR, WW3, and WW4 well logs for water saturation in the Upper Tulare Formation sands, which is present in the present in the upper 125 feet of the Upper Tulare Formation at TDS values of less than 10,000 ppm based on EPA log calculations. EPA concludes that portions of the Upper Tulare Formation are water saturated and qualify for classification as a potential USDW.

An aquifer exemption will be required to continue injection of Class I fluids in the Upper Tulare Formation within the proposed AOR.

42. Figure S-1, Map of the Midway-Sunset Oil Field and Extent of Exempted Aquifer:

Please delineate the horizontal and vertical limits of the proposed aquifer exemption on a map and cross-sections of the Upper Tulare Formation at the project area. Please also provide a written description of the proposed lateral and vertical exemption boundaries.